



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

P.O. BOX 621
HONOLULU, HAWAII 96809

APR -6 1994

KEITH W. AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

JOHN P. KEPPELER, II
DONA L. HANAIIKE

AQUACULTURE DEVELOPMENT
PROGRAM
AQUATIC RESOURCES
CONSERVATION AND
ENVIRONMENTAL AFFAIRS
CONSERVATION AND
RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

REF:WL-EK

Mr. Steven E. Morris
Vice President and General Manager
Puna Geothermal Venture
745 Fort Street Mall
Honolulu, Hawaii 96813

Dear Mr. Morris:

Proposed Change to Plan of Operations

Your proposed change to the plan of operations to drill Kapoho State No. 13 (KS-13), followed by Kapoho State No. 12 (KS-12), both as development wells, submitted by Mr. Thomas G. Kizis' letter of March 28, 1994 is approved.

Please note that after drilling has reached final target depth, and before a well cleanout test or injection test is performed, you will be required to designate each well as either a production or an injection well.

Should you have any questions, please contact Mr. Manabu Tagomori of the Division of Water and Land Development at 587-0230.

Very truly yours,

A handwritten signature in black ink, appearing to read "Keith W. Ahue".

KEITH W. AHUE

c: Mr. Thomas G. Kizis

JOHN WAIHEE
GOVERNOR OF HAWAII



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

P.O. BOX 373
HONOLULU, HAWAII 96809

April 5, 1994

KEITH W. AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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JOHN P. KEPPELER, II
DONA L. HANAIIKE

AQUACULTURE DEVELOPMENT
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CONSERVATION AND
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HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

Mr. Steven E. Morris
Vice President and General Manager
Puna Geothermal Venture
745 Fort Street Mall
Honolulu, Hawaii 96813

Dear Mr. Morris:

KS-12 and KS-13 Geothermal Well Drilling Permits

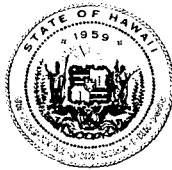
Enclosed for your attention and files are geothermal well drilling permits for wells Kapoho State No. 12 (KS-12) and Kapoho State No. 13 (KS-13).

Should you have any questions, please contact Mr. Gordon Akita of the Flood Control and Mineral Resource Branch at 587-0227.

Sincerely,

MANABU TAGOMORI
Manager-Chief Engineer

GA:ek



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

P.O. BOX 621
HONOLULU, HAWAII 96809

GEOTHERMAL WELL DRILLING PERMIT

KEITH W. AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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Kapoho State No. 13 (KS-13)
Kapoho, Puna, Hawaii

TO: Puna Geothermal Venture
P.O. Box 30
Pahoa, Hawaii 96778-0030
(808) 965-6233

Your application dated March 28, 1994, for a permit to drill a geothermal well on lands located within the Kapoho Section of the Kilauea Lower East Rift Geothermal Resource Subzone and covered under the State of Hawaii, Geothermal Resource Mining Lease No. R-5, is approved.

Well Designation:	Kapoho State No. 13 (KS-13)
Location:	TMK 1-4-01:19, Kapoho, Puna, Hawaii (Well Pad B)
Well Map Coordinates:	Latitude 19° 28' 56.6" N Longitude 154° 53' 23" W
Leased to:	Kapoho Land Partnership
Subleased to:	Puna Geothermal Venture
Operator:	Puna Geothermal Venture
Ground Elevation:	720 +/- ft. Above Mean Sea Level
Projected Depth:	7,500 +/- ft. True Vertical Depth

Approval is granted in accordance with the Department's Administrative Rules, Chapter 13-183, HAR, and under the following conditions:

- (1) All work shall be performed in accordance with the permission and terms of the occupiers of the land, the Drilling and Completion Program submitted with your application, the Department's Administrative Rules (Chapters 13-183 and 13-184, HAR), and all other applicable Federal, State, and County laws, ordinances, rules, and regulations;
- (2) The permittee, its successors and assigns shall indemnify, defend, and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit;

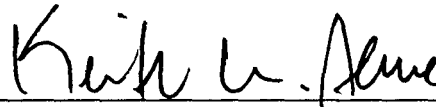
- (3) The permittee shall observe and comply with all valid requirements of County, State, and Federal authorities and regulations pertaining to the lands and permittee's operations including, but not limited to, all water and air pollution control laws and those relating to the environment;
- (4) The well and bottom-hole location shall be located more than 100 feet from the outer boundary of the parcel of land on which the well is situated, or more than 100 feet from a public road, street, or highway dedicated prior to the commencement of drilling, unless modified by the Chairperson upon request;
- (5) The permittee shall notify the Department of Land and Natural Resources, in writing, of the date of the start of drilling operations;
- (6) Prior to drilling, the permittee shall submit to the Department the bottom-hole target location and direction of any proposed deviation;
- (7) All Blow-Out Prevention Equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operation on the well. The minimum test pressures shall be approximately one-third of the casing internal yield pressure rating, provided that the test pressure shall not be less than 600 psig nor greater than 2500 psig, and shall be applied for a period of thirty minutes. The results of the pressure tests shall be reported on forms provided by the Department;

If a drop of more than ten percent of the casing test pressure is recorded, the operator shall run a caliper log and/or other appropriate well test to determine if the casing is defective and if corrective measures will be required before commencing any further operations. The results of the prescribed casing tests and any remedial work conducted shall be submitted to the Department within sixty days after completion;

- (8) Class "G" cement shall be used in the casing cementing operations and shall contain a high temperature resistant admix;
- (9) A real time monitoring device shall be installed for the driller and a pit alarm system shall be included with this monitoring device. All toolpushers, drillers, and derrickmen shall be schooled in the use of the recommended monitoring equipment;
- (10) If changes to the proposed drilling program are contemplated, the permittee shall obtain the Chairperson's approval before executing such changes;
- (11) When drilling has reached a depth of not more than 50 feet below sea level, the Department's representative shall be notified, with reasonable time allowed for travel to the site, to witness the retrieval of a representative groundwater sample and the measurement of the static water level. The permittee shall have the sample analyzed by an independent laboratory and have the results submitted to the Department;

GEOTHERMAL WELL DRILLING PERMIT
Kapoho State No. 13 (KS-13)
Page 3

- (12) A pressure and temperature survey, to inspect the mechanical integrity of the well, shall be performed after the well has been drilled to total depth, and before commencing the well cleanout flow or injection test;
- (13) During the use of the well for testing, monitoring, production and/or injection purposes, the well and site shall be properly maintained until the well is plugged and abandoned in accordance with the Department's Administrative Rules, Chapter 13-183, HAR;
- (14) The Permittee shall submit to the Chairperson, the results of any exploration, all drilling and testing records, down-hole surveys of the well, bottom-hole location, date of completion, and a survey of the well location and elevation above mean sea level taken by a Hawaii licensed surveyor within six months after completion of the well;
- (15) A well completion report, an as-built drawing of the well, and the location of the well plotted on an U.S.G.S. quad map shall be filed with the Department within six months after completion of the well;
- (16) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to its original condition; and
- (17) This permit shall expire 365 days from the date of issuance.



KEITH W. AHUE, Chairperson
Department of Land and Natural Resources

APR - 5 1994

Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
DBEDT
Department of Health
OEQC

DEPARTMENT OF LAND AND NATURAL RESOURCES

DOCUMENT NO.

UAC OR ATTACHED WORKSHEET

DATE:

YR	APP	D	SRC/ OBJ	COST CTR	PROJECT	PH	ACT	AMOUNT	NAME/DESCRIPTION (WANG INPUT)
00	000	C	1022	074				(1) 100.00	Puna Geothermal Venture
00	000	C	1022	074				(2) 100.00	Puna Geothermal Venture
								(3)	
								(4)	
TOTAL								200.00	

MARKS: LINE (1) KS-13 Permit to Drill Application
 LINE (2) KS-12 Permit to Drill Application
 LINE (3)
 LINE (4)

RECEIVED BY WANG WANG WANG WANG WANG

DELUXE FORM WVC-2 V-2

DATE	DESCRIPTION	AMOUNT
3/21/94	#4309 - Permit to Drill Applic KS-12; 0820-6179	100.00

**APPLICATION FOR PERMIT TO DRILL PROPOSED GEOTHERMAL
WELL
KAPOHO STATE 13 ON RESERVED LANDS, KAPOHO, PUNA HAWAII**

Complying with Department of Land and Natural Resources (DLNR) Administrative Rule, Title 13, Chapter 183, Subchapter 65, Puna Geothermal Venture (PGV) herewith makes application for Permit to Drill for approval by the Hawaii Board of Land and Natural Resources.

1. Applicant:

Puna Geothermal Venture
P.O. Box 30
Pahoa, Hawaii 96778-0030
(808) 965-6233

PUNA GEOTHERMAL VENTURE

By: Thomas G. Kizis
Thomas G. Kizis
Environmental Manager
Puna Geothermal Venture

Owner of Mining Rights:

Kapoho Land Partnership

Land Owner:

Kapoho Land and Development Company, Limited

2. Proposed well designation:

Kapoho State 13 (KS-13) off Wellpad B.

3. A tax key map, designating the approximate location of the drillsite for KS-13 off Wellpad B located on State Geothermal Mining Lease R-2; a topographic map, designating the approximate surface elevation at Wellpad B of 720 feet above mean sea level; and a PGV Project map, designating the relative locations of KS-13 and Wellpad B are contained in Attachment I.

Puna Geothermal Venture

4. The proposed PGV Project geothermal well KS-13 has been designed to intersect near-vertical fractures, approximately 4000-4700' below the surface. The primary drilling target will be for the purpose of providing geothermal resources to power the PGV project 25 MW power plant, previously approved in the Plan of Operation approved March 10, 1989 by the Board of Land and Natural Resources. A secondary drilling target will be for the purpose of reinjecting geothermal fluids and non-condensable gases produced by the operation of the power plant.
5. A detailed Summary of Drilling Procedures is enclosed in Attachment II.
6. A detailed Well Drilling and Completion Program, a Drillsite Plan, and a Vertical Section of the well KS-13 are contained in Attachment III.
7. A Summary of Drilling Reporting Criteria is enclosed in Attachment IV.
8. A description of Lithologic Logging Procedures is enclosed in Attachment V.
9. A multi-well drilling bond (\$25,000) has previously been filed with the State of Hawaii.
10. Puna Geothermal Venture agrees to perform such drilling as outlined in this application and agrees to maintain the well in accordance with Title 13, Chapter 183, State of Hawaii, and all Federal and County geothermal regulations.

ATTACHMENT I

**PUNA GEOTHERMAL VENTURE
APPLICATION TO DRILL KAPOHO STATE 13
A GEOTHERMAL WELL**

I. General Information

- a. Well Designation: Kapoho State 13
- b. Location: TMK 1-04--1:19
Kapoho, Puna, Hawaii (see Figure 1)
- c. State Geothermal Mining Lease: R-2
- d. Owner of Mineral Rights: Kapoho Land Partnership
- e. Subleased to: Puna Geothermal Venture
- f. Operator: Puna Geothermal Venture

II. Well Data

- a. Well Site: Well Pad B (see Figure 2)
- b. Well map coordinates: 154° 53' 23" W
19° 28' 56.6" N
- c. Well Type: Development Well
- d. Surface Elevation: 720' AMSL (see Figure 3)
- e. Projected Depth: 7500' TVD
- f. Target: Fractured basalt below 4000' M.D.

Well will be directionally drilled NNE to a target area which lies at a horizontal distance of between 1500' to 2000' north of Well Pad B at a depth of between 3000' and 7500' TVD (see Figure 2). Two possible targets may be encountered. The shallower target is a production zone which may consist of a steam dominated, steeply dipping fracture zone to be intersected at a depth of between 4000' and 4700' TVD. If this zone is not encountered, the drilling will be continued to a depth of 7500' TVD to intersect the pervasive, low permeability injection zone confirmed by drilling results from KS-1, 1A, 2, 3, and 4.

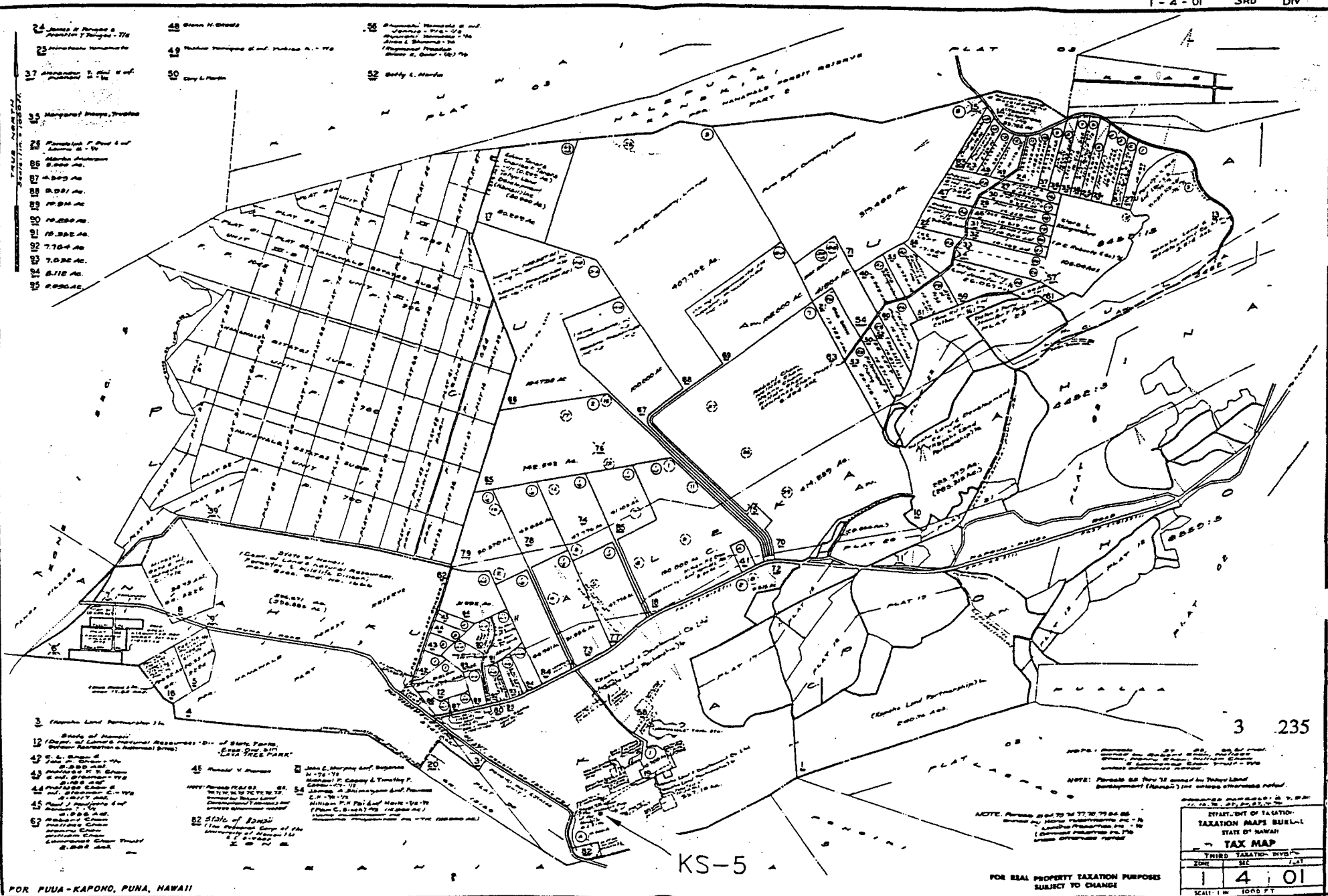
III. Geology

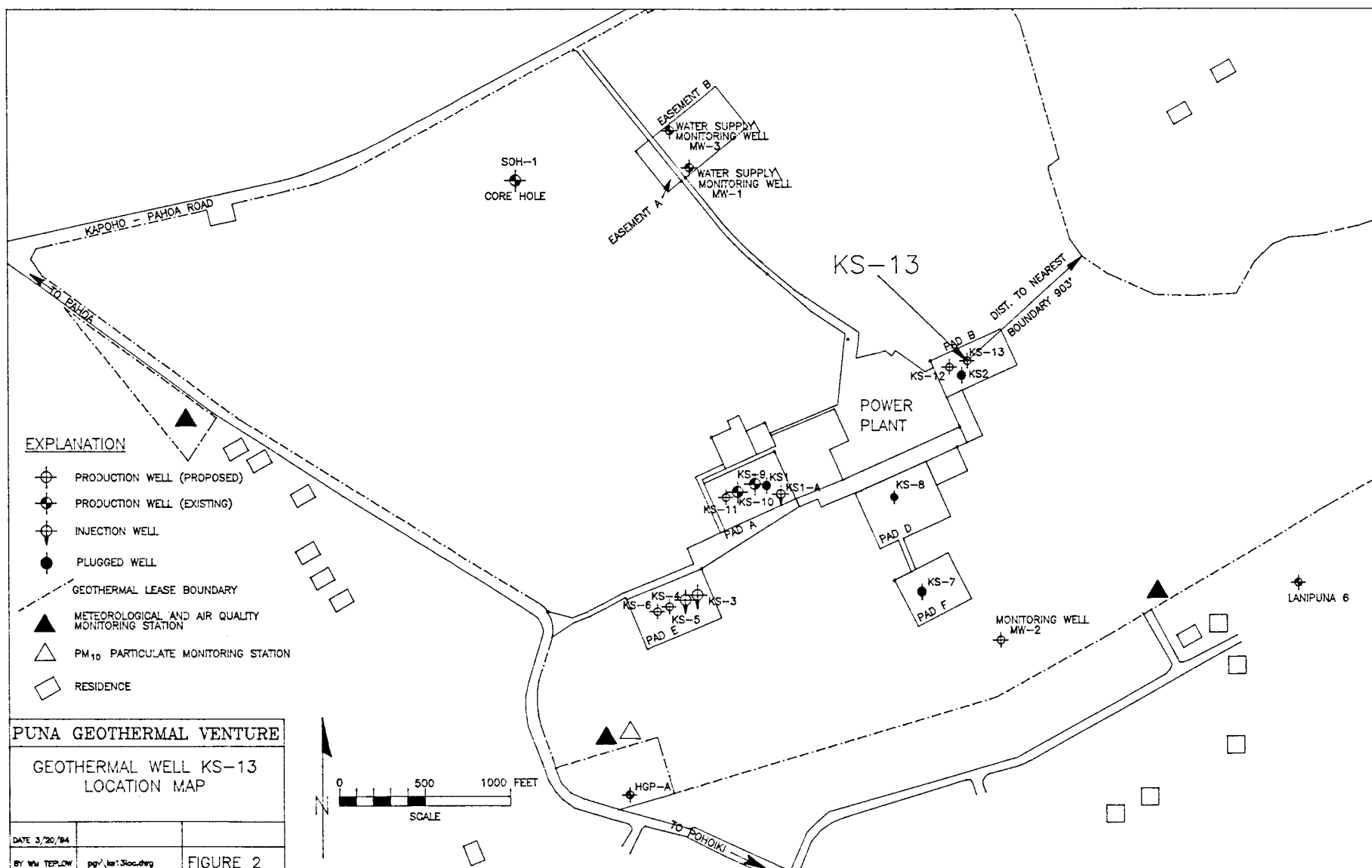
<u>Depth (MD):</u>	<u>Formation:</u>
0 - 627 ft.	Unsaturated subaerial basalt flows and intercalated cinder scoria.
627 ft.	Water Table
627 - 3000 ft.	Saturated subaerial basalt flows and intercalated cinder scoria; rare dikes.
3000 - 4000 ft.	Interbedded hyaloclastite deposits and minor subaerial grading into submarine basalt flows; localized dike swarms.

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4000 - 6500 ft.	Submarine basalt flows cross-cut by basalt dikes and possibly high-permeability, near-vertical fractures.
6500 - T.D.	Basaltic dike complex with locally recognizable submarine basalt flows.

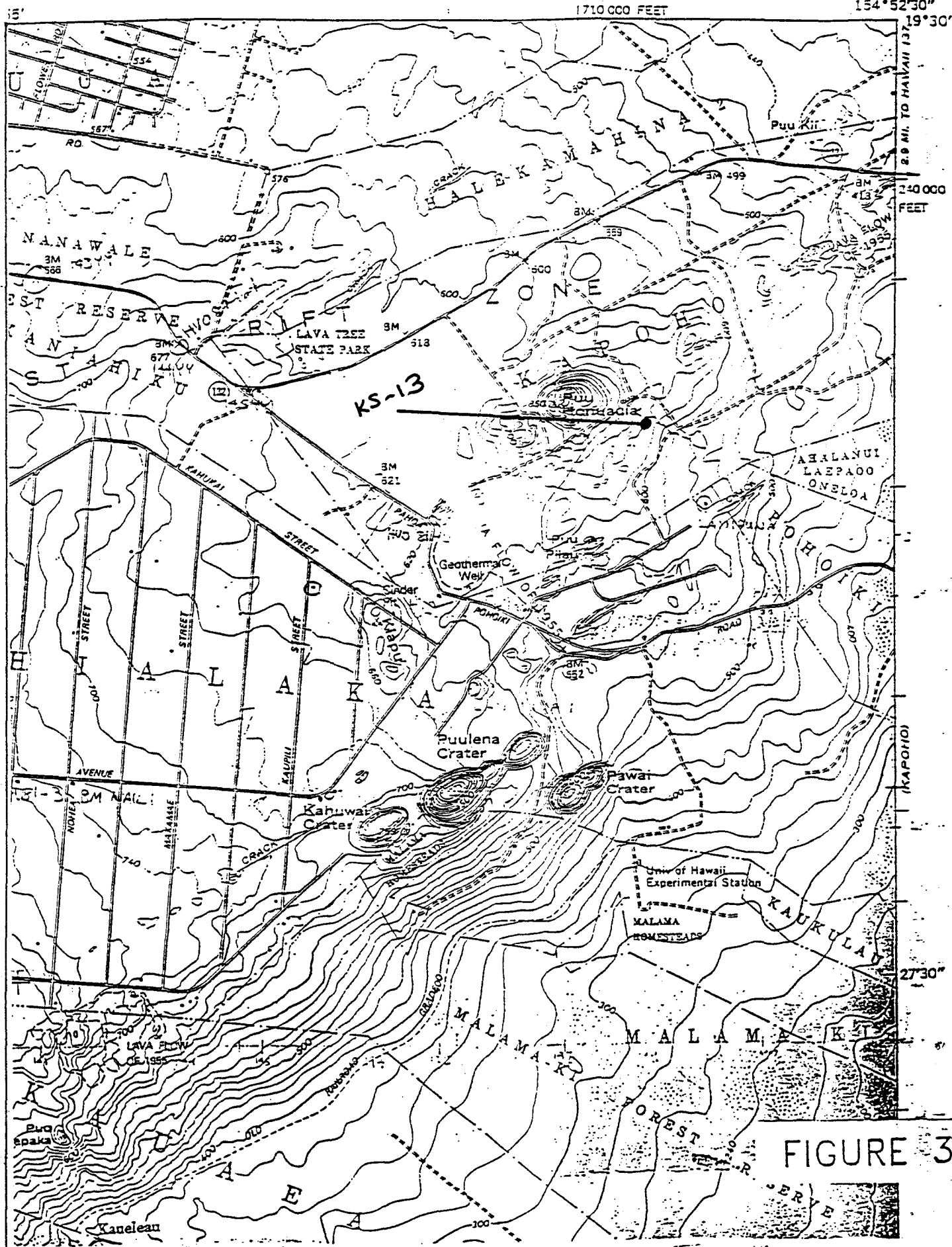
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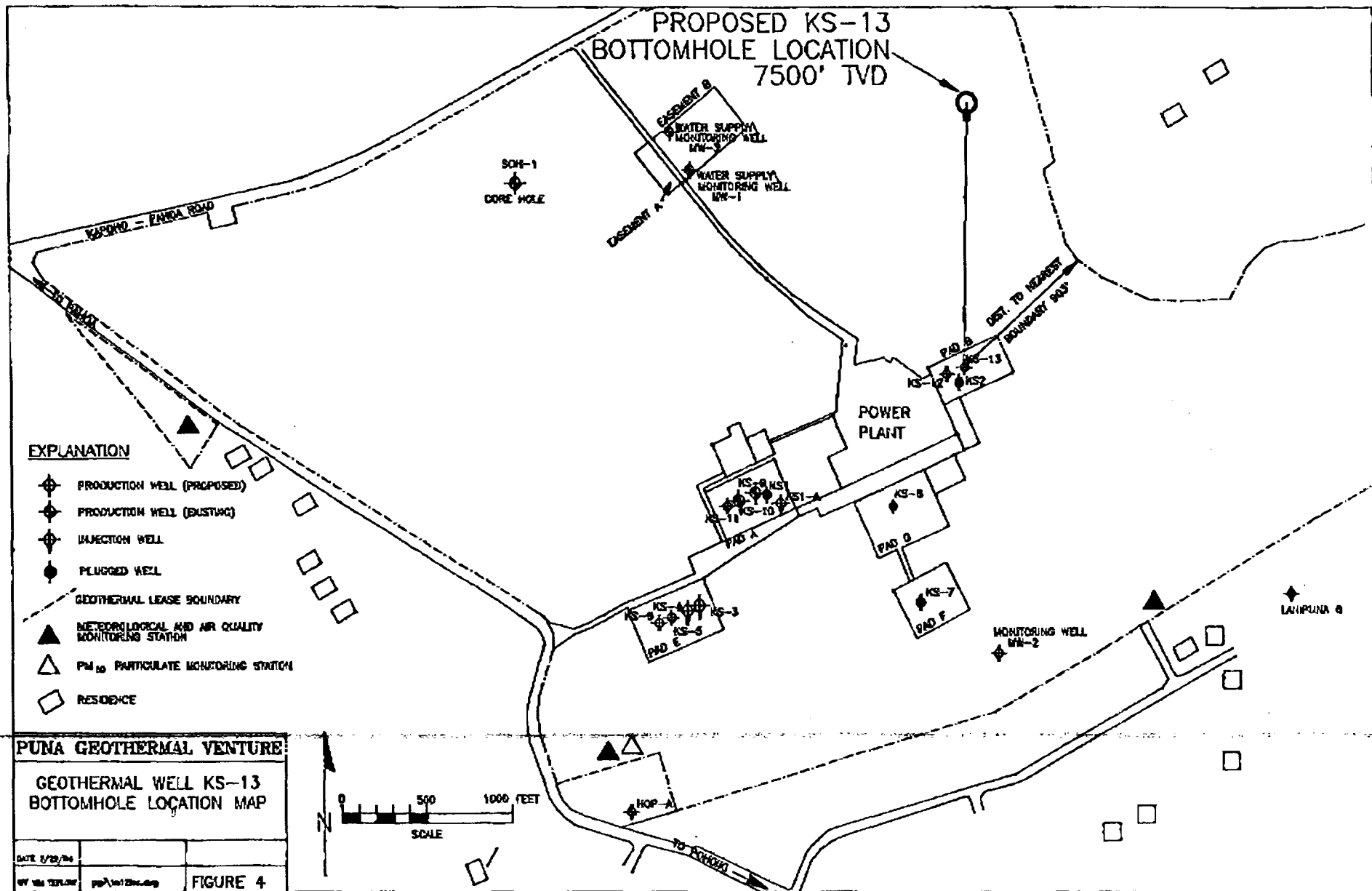




PAYA SOUTH QUADRANGLE
HAWAII-HAWAII CO.
ISLAND OF HAWAII-PUNA DISTRICT
7.5 MINUTE SERIES (TOPOGRAPHIC)

(KAPOLI)





ATTACHMENT II

**PUNA GEOTHERMAL VENTURE
KS-13 DRILLING PROCEDURES**

1. Move in suitable rig, air compressors and associated equipment.
 - 1.1 Notify DLNR 24 hours prior to rig up.
 - 1.2 Install sound proofing equipment.
 - 1.3 Install direct communication between floor, and both rig supervisor and operators supervisor.
 - 1.4 Driller will be on floor at all times.
 - 1.5 Read, understand and comply with all parts of the Plan of Operations that pertain to drilling.
 - 1.6 Send copies of daily tour sheets to DLNR.
 - 1.7 Adhere to attached Drilling Reporting Criteria as per the Plan of Operations.
2. Make up 9½" Navidrill on 17½" bit and 42" hole opener.
 - 2.1 Drill 42" hole to 50'±.
 - 2.2 Use 2000 cfm of air and 30-35 gpm of stiff foam as needed.
 - 2.3 Set 30" conductor pipe and concrete with 10 yds of ready mix.
3. Rig up 30" rotating head and flow line.
4. Drill 26" hole to 650'.
 - 4.1 Use 9½" NAVIDRILL and 2000 cfm air and 30-35 gpm stiff foam as needed.
 - 4.2 Take MRT every 90', with directional surveys when below 500 ft.
 - 4.3 Catch 10' grab samples from drill cuttings and monitor hydrothermal alteration. See Attachment 5 for mud logging procedures.
 - 4.4 Check returns, if any, for salinity and chlorides.
5. At 650', rig up bailer and bail well until clean. Collect a representative sample of ground water.
 - 5.1 Notify DLNR 24 hours prior to sampling procedure.
6. Continue drilling 26" hole to 1000'±. Casing shoe will be set in low permeability rock below major lost circulation zones. The casing will be set if high temperatures or hydrothermal alteration is encountered.

Puna Geothermal Venture

- 6.1 Keep hole straight as possible.
 - 6.2 Take surveys every 90' with MRT.
 - 6.3 Catch 10' grab samples from drill cuttings and monitor for hydrothermal alteration.
 - 6.4 Check returns for increased salinity or chlorides.
 - 6.5 Monitor well for flow or gases.
7. Circulate hole clean.
8. Make wiper run.
 - 8.1 Measure out of hole.
 - 8.2 Keep hole full at all times.
 - 8.3 Check for flow.
 - 8.4 Circulate hole clean after wiper run.
9. POH, keeping hole full, if possible, and checking for excess flow.
10. Rig up and run 1000'± of 20" 94# K-55 casing equipped as follows. Float shoe and flapper float insert one joint above shoe. Centralize 10' above shoe, first collar and every third collar there after.
 - 10.1 Run casing at slow speeds to prevent down surge.
 - 10.2 Fill casing with mud while running.
 - 10.3 Keep hole full.
 - 10.4 Have casing sized to remain 10' above TD.
11. Rig up 20" cementing head equipped with wiper plug.
 - 11.1 Circulate hole clean.
 - 11.2 Reciprocate casing 5-10' while circulating to prevent differential sticking.
12. Pump 50 ft³ H₂O ahead followed by 100 ft³ CaCl₂ H₂O mixed 10% plus 20 ft³ H₂O plus 250 ft³ Sodium Silicate plus 20 ft³ H₂O. Pump 100 ft³ Hawaii cement followed by 3040 ft³ premixed Hawaii cement, 1:1 perlite with 40% SSA-1 plus 2% gel, 0.75% CFR-3 and 2% CaCl₂, followed by 300 ft³ Hawaii cement mixed 40% SSA-1, 0.75% CFR-3 and 3% CaCl₂. Drop plug and displace cement.
 - 12.1 Reciprocate casing 5-10' while cementing to prevent differential sticking.
 - 12.2 Monitor returns and surface pressures throughout job.
 - 12.3 Center casing and WOC.
 - 12.4 Be prepared to do top job through 1" pipe with high density cement.

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- 12.5 Have at least 20 cubic yards of sand, gravel, and or volcanic cinders on hand to fill annulus through lost circulation zones if required.
- 12.6 WOC minimum of 12 hours.
- 12.7 Perform top job as required.
- 13. Cut off casing and weld on 20" 2000# slip on well head with 2 side outlets. Valve the outlets with 3" 2000# RTJ gate valves.
 - 13.1 Test casing head and log on tour sheets.
- 14. Install 20" annular preventer, 20" side outlet spool, diverter valve and line, and rotating head as shown in Figure 3-4. Install H₂S abatement equipment on diverter line.
 - 14.1 Notify DLNR 24 hours prior to testing.
 - 14.2 Test BOPE and have DLNR witness and approve.
 - 14.3 Log test results on tour sheet and morning report.
 - 14.4 Periodic BOPE drills will be conducted and logged on tour sheets.
 - 14.5 Install and test and run high efficiency mud cooler.
 - 14.6 All personnel will have BOPE training. Training will be logged on the daily tour report.
- 15. Make up 17½" slick BHA. Clean out cement.
- 16. Drill 5' of new 17½" hole and circulate clean.
- 17. Perform leak off test and squeeze if necessary.
 - 17.1 Notify DLNR 24 hours prior to testing.
 - 17.2 Have DLNR witness and approve leak off test.
- 18. Make up BHA and drill 17½" hole to 2000'±.
 - 18.1 Keep hole straight.
 - 18.2 Survey every 90' and run MRT.
 - 18.3 Catch 10' grab samples of drill cuttings.
 - 18.4 Check mud for increased salinity and chlorides.
 - 18.5 Monitor well for increase or decrease in flow rates and gases.
 - 18.6 Keep close watch on samples for changes in mineralogy indicative of a high-temperature geothermal reservoir.
 - 18.7 Cement off loss circulation zones.
 - 18.8 Be prepared to set casing if there are any signs of encountering a high-temperature reservoir.

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19. Circulate hole clean and make wiper trip to shoe. Circulate hole clean.
20. POH
 - 20.1 Measure out of hole.
 - 20.2 Keep hole full.
 - 20.3 Monitor well and be sure well takes proper amount of fluid.
21. Rig up and run 2000'± 13³/₈" 61# and/or 68# K-55 New Vam casing equipped as follows. Float shoe and Davis Lynch screw-in latch down float collar placed 2 joints above shoe. Centralize 10' above shoe, on first, second and third collar. Centralize every third collar thereafter.
 - 21.1 Use safety collars while running csg.
 - 21.2 Use thread protectors.
 - 21.3 Use Stab-in guides if available.
 - 21.4 Run casing at slow speeds to prevent down surge.
 - 21.5 Fill casing with mud while running.
 - 21.6 Keep monitoring well.
 - 21.7 Keep hole full.
 - 21.8 Have casing sized to remain 10' off bottom.
22. Rig up and run 5" drill pipe with Davis Lynch screw-in sub.
 - 22.1 Screw into float collar.
 - 22.2 Be sure casing is full of mud.
 - 22.3 Circulate and condition hole for cement job.
 - 22.4 Observe casing and drill pipe annulus, to be sure stab-in is not leaking.
 - 22.5 Reciprocate casing while circulating to prevent differential sticking.
23. Pump 50 ft³ H₂O ahead followed by 50 ft³ CaCl₂ H₂O and 133 ft³ Sodium Silicate, and 10 ft³ H₂O. Pump 50 ft³ Hawaii cement followed by 3000 ft³ Hawaii cement, mixed 1:1 perlite with 40% SSA-1 plus 2% gel 0.65% CFR-3 and retarded, as required, followed by 300 ft³ Hawaii cement with 40% SSA-1 0.75% CFR-3. Drop plug and displace cement.
 - 23.1 Reciprocate casing 5-10' while cementing.
 - 23.2 If casing becomes excessively sticky during cementing phase, place casing at proper position and centralize.
 - 23.3 Monitor returns and pressures throughout job.
 - 23.4 Be prepared for top job.
24. WOC at least 12 hours.

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25. Cut off casing and install 13³/₈" x 13⁵/₈" 5000# casing head, using hot head.
26. Install 13⁵/₈" 5000# mud cross, 13⁵/₈" 5000# double gate, 13⁵/₈" 5000# banjo box with rupture disk and single gate, 13⁵/₈" 5000# double gate, 13⁵/₈" 5000# annular preventer, rotating head, choke and kill lines, blooie line and muffler. Also include water lines and abatement lines as per Figure 3-8 in Attachment III. Install and check all monitoring equipment including driller assistant.
 - 26.1 Notify DLNR 24 hours prior to test.
 - 26.2 Test BOPE and have DLNR witness and approve.
 - 26.3 Log test results and approval of test on tour sheets and morning report.
 - 26.4 All pushers, drillers and derrick men will be trained in use of monitoring equipment and this training will be logged in IADC tour sheets.
27. Use 12¹/₄" bit with slick BHA and clean out cement and floats.
28. Drill approximately 5' of new hole and circulate hole clean.
29. Perform leak-off test, and squeeze cement if necessary.
 - 29.1 Notify DLNR 24 hours prior to testing.
 - 29.2 Have DLNR witness and approve leak off test.
30. POH. Make up 12¹/₄" bit and tools. Drill 12¹/₄" hole to 3900'±. Casing point will be in the cap rock above the reservoir as determined by the wellsite geologist using criteria described in the Plan of Operations.
 - 30.1 Do directional work and drill 12¹/₄" hole to 3900'±. See directional program.
 - 30.2 Survey as required at intervals not to exceed 120'. Take MRT with surveys.
 - 30.3 Catch 10' grab samples of drill cuttings.
 - 30.4 Keep close watch on mud properties.
 - 30.5 Monitor well for increase or decrease in flow rates and gases.
 - 30.6 Keep close watch on samples for changes in mineralogy indicative of a high-temperature geothermal reservoir.
 - 30.7 Cement off lost circulation zones.
31. Circulate hole clean and wipe hole to shoe. Circulate hole clean.
32. POH and rig up to run 9⁵/₈" liner on liner hanger, providing 200 linear feet of lap. Equip liner as follows. Float shoe and float collar 80' up from shoe. Centralize liner 10' up from shoe, on 1st, 2nd, 3rd and every 4th collar thereafter or as per program. Liner hanger to have tie-back capability.

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- 32.1 Make up liner hanger prior to running liner and stand back in derrick.
- 32.2 Run approximately 2100' of 9⁵/₈" 47# C90 New Vam casing.
- 32.3 Use safety collars while running casing.
- 32.4 Run casing at slow speeds to prevent down surge on formation.
- 32.5 Fill casing while running.
- 32.6 Keep hole full.
- 32.7 Monitor well closely.
- 32.8 Be cautious of slips on hanger when running through BOPE.
- 32.9 Run and hang liner and break nut.
- 33. Rig up and circulate hole clean and condition mud for cement job.
- 34. Pump 50 ft³ H₂O ahead plus 133 ft³ foamed flow check, and 10 ft³ H₂O followed by foamed Hawaii cement with 40% SSA-1, required additives, and retarded as needed, followed by 85 ft³ Hawaii cement with 40% SSA-1 + 0.65% CFR-2. Drop dart and displace cement.
 - 34.1 Monitor well closely while cementing.
- 35. Release liner and strip out of hole 200' using Hydril to keep pressure on annulus constant.
- 36. WOC for minimum of 4 hours. POH. WOC an additional 8 hours.
- 37. RIH with 12¹/₄" bit and clean out cement to top of liner hanger.
- 38. Make up 8¹/₂" bit and clean out liner hanger.
- 39. Test liner lap to 0.9 psi/ft. gradient. Squeeze cement and retest if necessary.
- 40. Make up Stab-in for tie back receptacle and 1800'± of 9⁵/₈" 47# C-90 New Vam casing, equipped with insert float on top of 1st joint and centralized with positive centralizers on 1st, 2nd and every 3rd collar thereafter with positive centralizers.
 - 40.1 Size casing so collar will not be in expansion spool packoff.
- 41. Circulate hole clean.
 - 41.1 Install centering ring.
- 42. Pump 50 ft³ H₂O ahead followed by 970 ft³ Hawaii cement with 40% SSA-1 + 0.65% CFR-3 + 3% gel. Drop plug and displace to insert.
- 43. WOC 16 hours.

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- 44. Cut off casing and install expansion spool with donut hanger. Test with nitrogen.
- 45. Install BOP stack for 9⁵/₈" casing including master valve (see Figure 3-6).
 - 45.1 Notify DLNR 24 hours prior to testing BOPE.
 - 45.2 BOPE to be tested to 2500 psi.
 - 45.3 Test to be witnessed and approved by DLNR.

COMPLETION STEPS FOR PRIMARY DRILLING TARGET

- 46. Clean out casing and drill 5' of new 8¹/₂" hole.
 - 46.1 Circulate hole clean.
 - 46.2 Perform leak-off test and squeeze if necessary.
- 47. Drill 8¹/₂" hole to 7500'± TVD or until sufficient production is encountered.
 - 47.1 Take surveys every 120' and include MRT.
 - 47.2 Catch 10' grab samples of drill cuttings.
 - 47.3 Keep close watch on mud properties. Weight up as needed to control well.
 - 47.4 Be sure all monitoring equipment is in good working order.
 - 47.5 Watch closely for flow or loss.
 - 47.6 Watch closely for changes in mineralogy indicative of high-temperature geothermal reservoir.
- 48. At TD circulate hole clean.
 - 48.1 Displace mud with water or completion fluid.
- 49. Perform preliminary flow test to muffler to clean out well. Run necessary surveys to confirm mechanical integrity.
- 50. At conclusion of rig test notify Puna Geothermal office for decision whether or not to complete well as open hole or with 7" perforated liner.
- 51. Lay down drill pipe and tools.
- 52. If needed, rig and run 7" protective hang down string and hang with donut from top of expansion spool. Keep bottom of 7" 100' above top of perforated liner.
- 53. Secure well.

Puna Geothermal Venture

- 54. Install companion flange and swab valve.
- 55. Rig down and move rig.
- 56. Release well to O&M.

COMPLETION STEPS FOR SECONDARY DRILLING TARGET

- 46. Drill approximately 5' of new 8¼" hole and circulate hole clean.
- 47. Perform leak-off test and squeeze if necessary.
 - 47.1 Notify DLNR 24 hours prior to testing.
 - 47.2 Have DLNR witness and approve leak-off test.
- 48. Drill 8½" hole to 7500'± TVD or until sufficient injectivity is encountered.
 - 48.1 Take surveys every 120' and include MRT.
 - 48.2 Catch 10' grab samples of drill cuttings.
 - 48.3 Keep close watch on mud properties. Weight up as needed to control well.
 - 48.4 Be sure all monitoring equipment is in good working order.
 - 48.5 Watch closely for flow or loss.
 - 48.6 Watch closely for changes in mineralogy indicative of high temperature geothermal reservoir.
- 49. At TD circulate hole clean.
 - 49.1 Displace mud with water or completion fluid.
- 50. Perform preliminary flow test to muffler to clean out well.
- 51. If needed to maintain hole stability, run 7" perforated liner from 100' above the 9⅝" shoe to T.D.
- 52. Lay down drill pipe and tools.
- 53. Perform injection test and surveys to inspect mechanical integrity of well.
- 54. If required, run 7" hang down string and hang from donut hanger at surface to within 100' of the top of the 7" perforated liner.

Puna Geothermal Venture

55. Secure well.
56. Install companion flange and swab valve.
57. Rig down and move rig.
58. Release well to O&M.

ATTACHMENT III

**PUNA GEOTHERMAL VENTURE
DEVELOPMENT WELL DRILLING PROGRAM
FOR WELL KS-13**

CONDUCTOR CASING AND CELLAR:

A thirty inch (30") conductor pipe will be set in a 42" hole that was drilled to a depth of 50' below ground level. The conductor is to be cemented in place with a Type II portland concrete cement placed down the backside of the 30" conductor pipe.

Following the setting of the conductor pipe, dig an earthen cellar and construct a reinforced concrete cellar according to civil contractor's design and specifications (Figure 3-1).

DRILLING - 26" HOLE:

Rig up a suitable drilling rig as shown in Figure 3-2. Weld on 30" pitcher nipple. Spud in with 26" bit. Anticipate losing total returns at any time below surface. Continue drilling ahead on water, aerated mud or foam without returns. Run maximum reading thermometers during directional surveys every 90' below a depth of 500'. Drill to a depth of 650'.

At this depth rig up bailer and bail continuously or as required to get a representative ground water sample. Collect samples and send to lab for analysis. Have state witness sampling procedure. Notify state 24 hours prior to taking samples.

Resume drilling 26" hole on water, aerated mud, or foam. Drill to a depth of 1000' +/-, the casing point for 20" casing. If abnormal temperatures are encountered, notify the drilling superintendent and stop drilling. The 20" casing may be set at that point after consulting with and receiving permission from Department of Land and Natural Resources (DLNR).

SURFACE CASING:

Approximately 1000' of 20" 94# K55 BT&C casing will be run and cemented in place (see Figure 3-3). Run casing while filling on every second joint.

Cement 20" casing through drill pipe with type II + 40% silica flour + 2% calcium chloride + .65% CFR-3. Excess is calculated at 100%. Reciprocate casing 10' - 15' throughout job.

Wait on cement for 12 hours. Have at least 200 cubic yards of sand, gravel, and/or volcanic cinders on hand.

Puna Geothermal Venture

Pick up and run 1" tubing down backside of 20" casing. Tag fill. Mix and pump type II cement + 40% silica flour + 2% calcium chloride + .65% CFR-3. Circulate to surface. Pull tubing and wash shield laying down. Wait on cement for 12 hours. Should the cement settle, top out with batched ready-mix poured down the backside of the 20" casing. Ready-mix can be accelerated with 2% by weight of calcium chloride. Wait on cement for 12 hours.

BLOWOUT PREVENTION EQUIPMENT (20-inch BOPE) 17½" HOLE (Figure 3-4):

Cut off casing and weld on 20" 2000# slip on casinghead with 2 side outlets. Valve the outlets with 3" 2000# RTJ gate valves.

Blowout prevention equipment to drill a 17½" hole shall consist of a 20" 2000# annular preventer and diverter system as shown in Figure 3-4. Test BOPE per State requirements and note test results in IADC tour report and morning report. Notify appropriate State regulatory agencies 24 hours prior to testing.

DRILLING 17½" HOLE:

Drill out from underneath the 20" surface casing with mud, a 17½" mill tooth bit, and slick bottomhole assembly. Perform leak-off test by pressuring well to the equivalent of 11#/gal fluid and note test results in IADC tour report and morning report. Notify appropriate state regulatory agencies 24 hours prior to testing. Drill out and trip for bottomhole assembly.

Should lost circulation persist, loss interval(s) should be cemented.

The 17½" hole is to be drilled to a depth of 2000' +/- where 13⅜" casing is to be run.

INTERMEDIATE CASING:

Approximately 2000' of 13⅜" 61# K55 NEW VAM casing is to be run and cemented in place in a single stage (see Figure 3-3).

Cement with type II cement + 40% silica flour + .65% CFR-3. If losses are encountered below the 20" casing shoe, it may be advisable to cement the 13⅜" string with a light weight spherulite cement slurry tailed by 200 sacks of type II slurry. Pump 60% excess.

BLOWOUT PREVENTION EQUIPMENT (13⅜" BOPE) - 12¼" HOLE (Figure 3-5):

Cut off casing and install 13⅜" X 13⅝" 5000# casinghead. Blowout prevention equipment to drill a 12¼" hole will consist of two 13⅝" 5000# double gate preventers, a 13⅝" 5000# Hydril annular preventer, a banjo box with rupture disk and single gate preventer on the side outlet, a rotating drilling head, choke, and kill line (see Figure 3-5). Test BOPE as per State requirements and note

Puna Geothermal Venture

test results in IADC tour report and morning report. Notify appropriate state regulatory agencies 24 hours prior to testing. Install blooie line and muffler. Install hydrogen sulfide abatement equipment on blooie line (Figure 3-8).

DRILLING 12¼" HOLE:

Drill out the shoe with a 12¼" bit and slick bottomhole assembly. Perform leak-off test by pressuring well to the equivalent to 11#/gal fluid and note test results in IADC tour report and morning report. Notify appropriate state regulatory agencies 24 hours prior to testing. Squeeze if required. Trip for bottomhole assembly. Drill to casing point at 3900' +/-.

PRODUCTION CASING (Primary Drilling Target):

Approximately 3900' of 9⅝" 47# C90 NEW VAM casing is to be run and cemented (see Figure 3-3). Cement casing type II cement + 40% silica flour + 50 lb/sk of spherulite + 4% gel + 1.25% CFR-3 + 1.5% HALAD 22A. Excess is calculated at 60%. After WOC, cut off the 9⅝" casing. Dress casing 8" above casinghead flange with 27½° chamfer. Nipple up 13⅝" 5000# x 10" 5000# Type S WKM Expansion Spool with packing sleeve.

INJECTION CASING (Secondary Drilling Target):

Approximately 3900' of 9⅝" 47# C90 NEW VAM casing is to be run and cemented (see Figure 3-3). Cement casing type II cement + 40% silica flour + 50 lb/sk of spherulite + 4% gel + 1.25% CFR-3 + 1.5% HALAD 22A. Excess is calculated at 60%. After WOC, cut off the 9⅝" casing. Dress casing 8" above casinghead flange with 27½° chamfer. Nipple up 13⅝" 5000# x 10" 5000# Type S WKM Expansion Spool with packing sleeve.

BLOWOUT PREVENTION EQUIPMENT (9⅝" BOPE) - 8½" HOLE (Figure 3-6):

Blowout prevention equipment to drill the 8½" section of hole should consist of a 10" 5000# WKM gate valve, 10" 5000# x 13⅝" 5000# DSA, two 13⅝" 5000# double gate preventers, a 13⅝" 5000# Hydril annular preventer, a banjo box with a valve on the side outlet (and a single-gate preventer as required by conditions), a rotating drilling head, choke, and kill line (see Figure 3-6). Test BOPE as per State requirements and note test results in IADC tour report and morning report. Notify appropriate state regulatory agencies 24 hours prior to testing. Install blooie line and muffler. Install hydrogen sulfide abatement equipment and muffler on choke line. Provisions will be made to abate any well flow from the choke line or the blooie line.

DRILLING 8½" HOLE:

Drill out from underneath the 9⅝" casing on water with an 8½" bit and slick bottomhole assembly. Perform leak-off test and note test results on IADC tour report. Squeeze if required. Notify

Puna Geothermal Venture

appropriate state agencies 24 hours prior to testing. Trip for packed BHA and continue drilling ahead on mud.

Should differential sticking occur, rig up the air compressor with the degasser to free the stuck string.

At 7500' +/- TVD circulate out mud with fresh water. Trip-out of hole and rig up flow test. If test is successful, run injection liner if required.

PRODUCTION LINER (Primary Drilling Target):

Trip in hole with slick BHA and check for fill. If hole is opened, run approximately 3800' of 7" 29# L80 BT&C casing slotted with 1/4" x 2" slots on 12 row pattern. Run liner with cement guide shoe on bottom and hang on 7" x 9 5/8" single slip cone type liner hanger (see Figure 3-3). Release from hanger and trip out laying down.

Nipple down BOP and install final wellhead for production well as shown in figure 3-7.

INJECTION LINER (Secondary Drilling Target):

Trip in hole with slick BHA and check for fill. If hole is opened, run approximately 3800' of 7" 29# L80 BT&C casing slotted with 1/4" x 2" slots on 12 row pattern (see Figure 3-3). Run liner with cement guide shoe on bottom and hang on 7" x 9 5/8" single slip cone type liner hanger. Release from hanger and trip out laying down.

Nipple down BOP and install final wellhead for injection well as shown in Figure 3-7. An optional 7" tie back injection liner may be installed. Run approximately 3700' of 7" 29# SM-22 New Vam casing and hang on donut type hanger set in top of 10" X 13 5/8" expansion spool (see Figure 3-3). Figure 3-7A shows the injection wellhead configuration from KS-13.

Figure 3-7A shows the injection wellfield configuration for KS-13.

ATTACHMENT IV

**PUNA GEOTHERMAL VENTURE
DRILLING REPORTING CRITERIA**

1. The Drilling Supervisor shall report to the PGV Drilling Engineer or his designated relief on the day to day operations.
2. As closely as possible, the Drilling Supervisor will follow the drilling program for a particular well as provided by the Drilling Engineer. There will be changes in the drilling program as the well progresses and these changes must be discussed with the Drilling Engineer before action is taken.
3. Approximate casing setting depth will be set in the Drilling Program with assistance from the Geologist. These depths should be used absent other information. A mud program will be outlined in the Drilling Program and this program should be followed as closely as possible. The Drilling Supervisor shall have ample latitude to change the mud program as dictated by the actual drilling conditions.
4. Historical drilling data have been developed regarding the PUNA GEOTHERMAL PROJECT and this data should be used to advantage in drilling wells within the project.
5. In and out mud temperatures and maximum recording temperatures will be logged on the IADC tour sheet.
6. When drilling below the 13³/₈-inch casing shoe, special precautions must be taken when encountering any lost circulation zones or drilling breaks.
7. If a drilling break is encountered when drilling, the Kelly should be picked up and bottoms up should be circulated around. The PGV Drilling Supervisor should be immediately notified along with the contractor's supervisor. A temperature survey should be run whenever a drilling break is encountered. An interpretation of the survey should be made by the Drilling Engineer before drilling further. It is important not to drill ahead with excessive temperature in the mud returns.
8. The driller should also note in the IADC Tour report of any gains or losses in mud pit volume. Any significant mud loss should be reported to the PGV and the Contractor's supervisors. If any continuous or significant mud gain is encountered, the driller should pick up the kelly and check for flow and notify the supervisors. If flow is observed, the well will be shut in immediately.

Puna Geothermal Venture

9. Based on past experience in the PUNA GEOTHERMAL PROJECT, it is imperative that constant supervision of the well be accomplished once drilling is undertaken below the 13³/₈-inch casing shoe.
10. PGV Supervisors will be in charge of all activities on location. PGV Supervisors will report to the PGV Drilling Engineer.
11. Drilling Supervisors will spend sufficient time together at the rig during change out to exchange information on the current activities. Drilling Supervisors will be on the floor, on the pump truck, in the wireline unit, etc. for all critical operations.
12. The Drilling Engineer will be responsible for engineering programs with input from the Drilling Supervisors. The Drilling Engineer will also advise and assist the Drilling Supervisors.
13. Contractor's supervisors will report to the Drilling Supervisor on location. They will also be on the floor during all crew changes.
14. Drillers and crews will work eight hour shifts. Reporting procedures for crews will be the responsibility of the drilling contractor. Drillers will log all rig operations on the IADC Daily Tour sheet, including the depths of all work performed. Rig crew will assist service company personnel as directed by the contractor's supervisor.

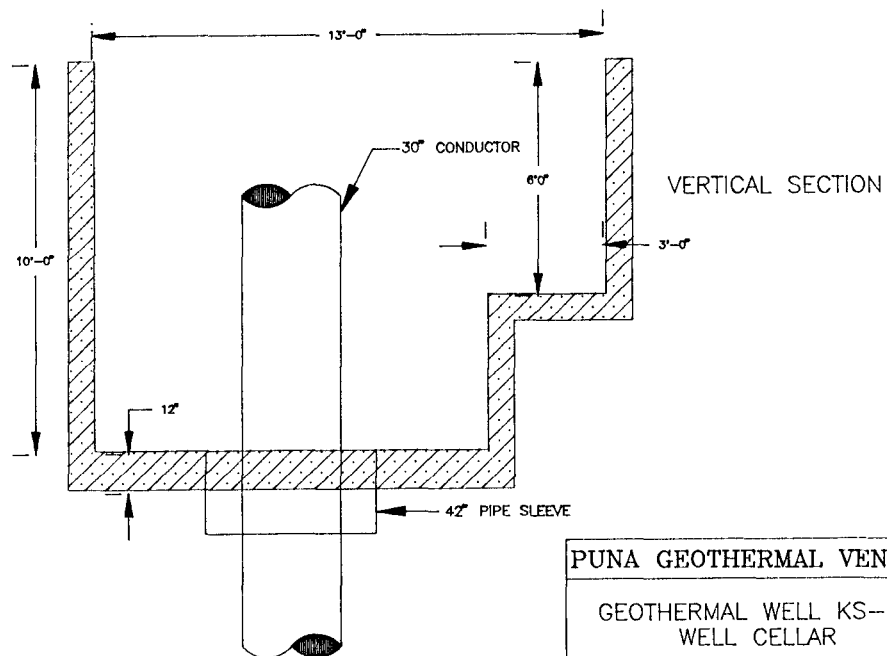
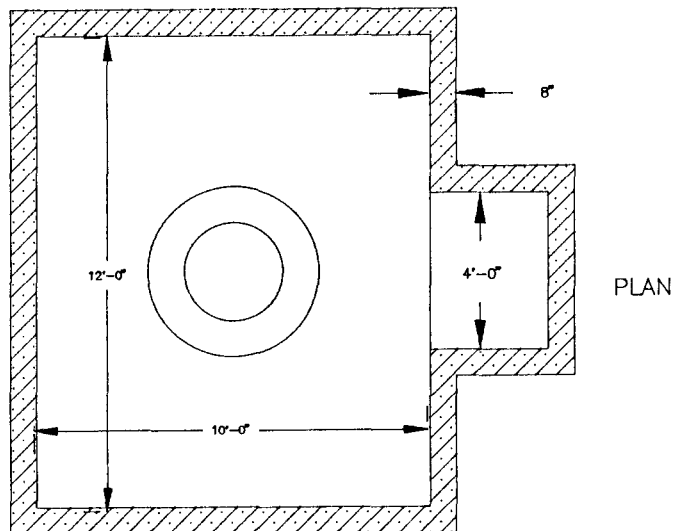
ATTACHMENT V

**PUNA GEOTHERMAL VENTURE
PROCEDURES FOR LITHOLOGIC LOGGING**

While drilling, depths are recorded on a Bristol chart (a circular chart matching time versus depth). As a single joint is drilled, each ten foot interval (i.e. 100, 110, 120, etc.) is marked and labeled on the chart. A lag time (the interval of time, measured in minutes, required to circulate drilling fluids from the bit to the surface) is calculated based on hole size and pump rates and a marker is set to indicate when a marked depth reaches the surface.

When drilling fluids containing suspended drill cuttings derived from a given interval reach the surface, it travels down the flow line and over the mesh shaker screens. After the latest ten foot interval has accumulated at the base of the shakers, the mud logger obtains a representative sample of the drill cuttings. The sample is then washed of the drilling fluid. One portion of the cuttings, the wet sample, is placed in a plastic bag and the remainder is dried and bagged in sample sets.

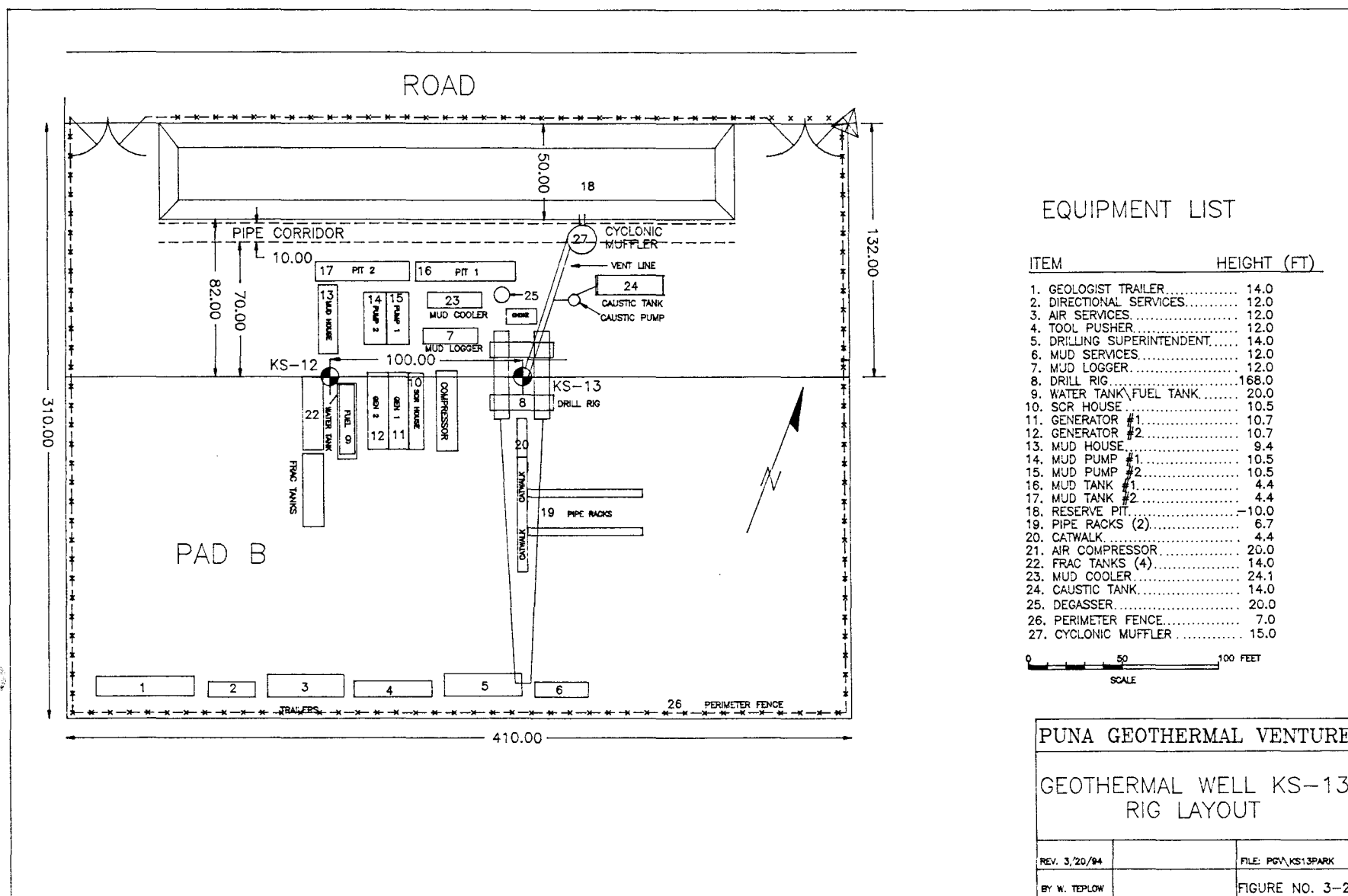
A small amount is retained to view under a stereomicroscope. The cuttings from each ten foot interval are then visually and physically evaluated. Detailed written descriptions of each ten foot interval are entered on work sheets which are subsequently summarized onto the mud log data sheet. The lithologic descriptions includes rock type, color, texture, hardness, structural characteristics, alteration (if any) and secondary mineralization.

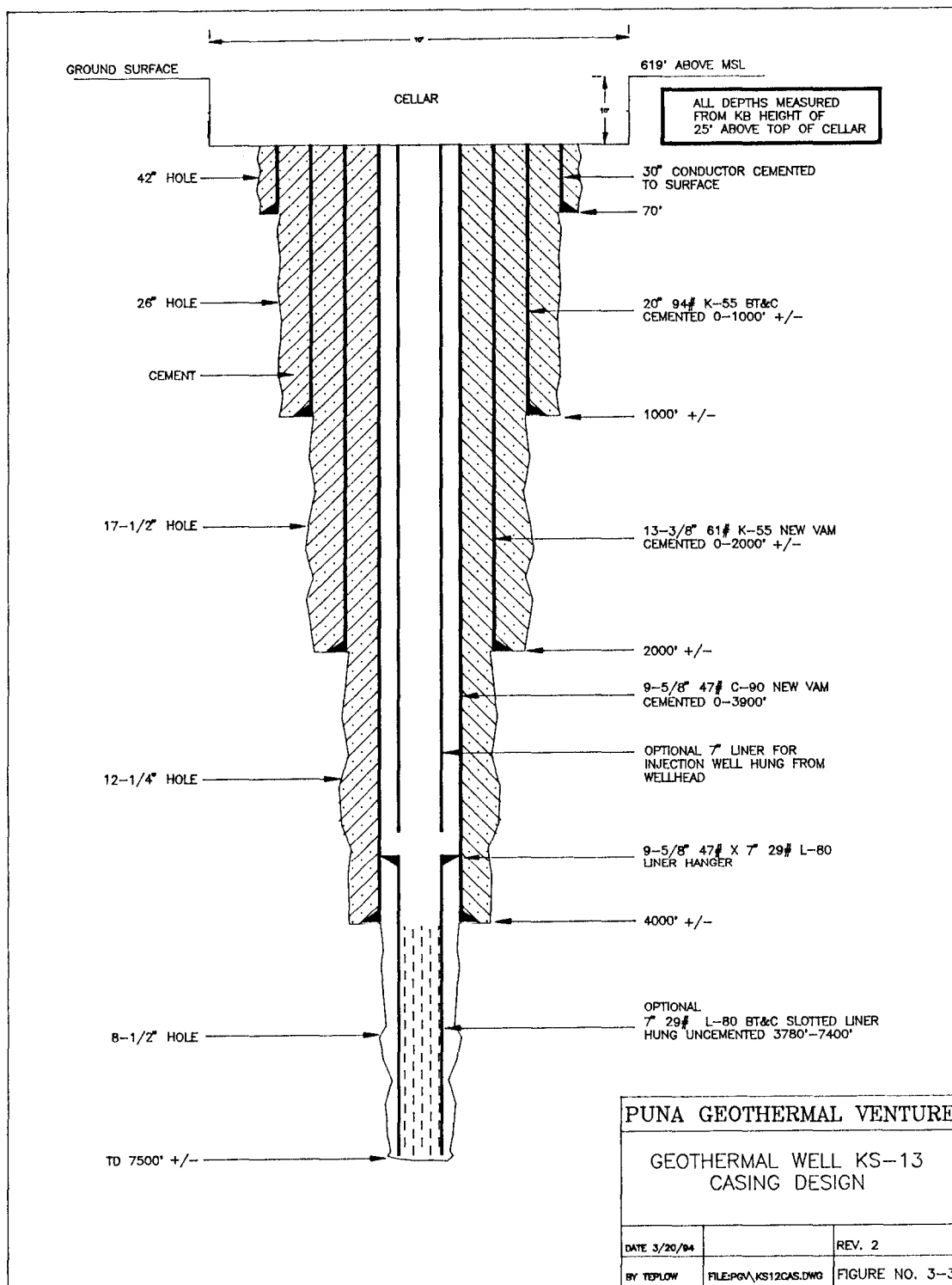


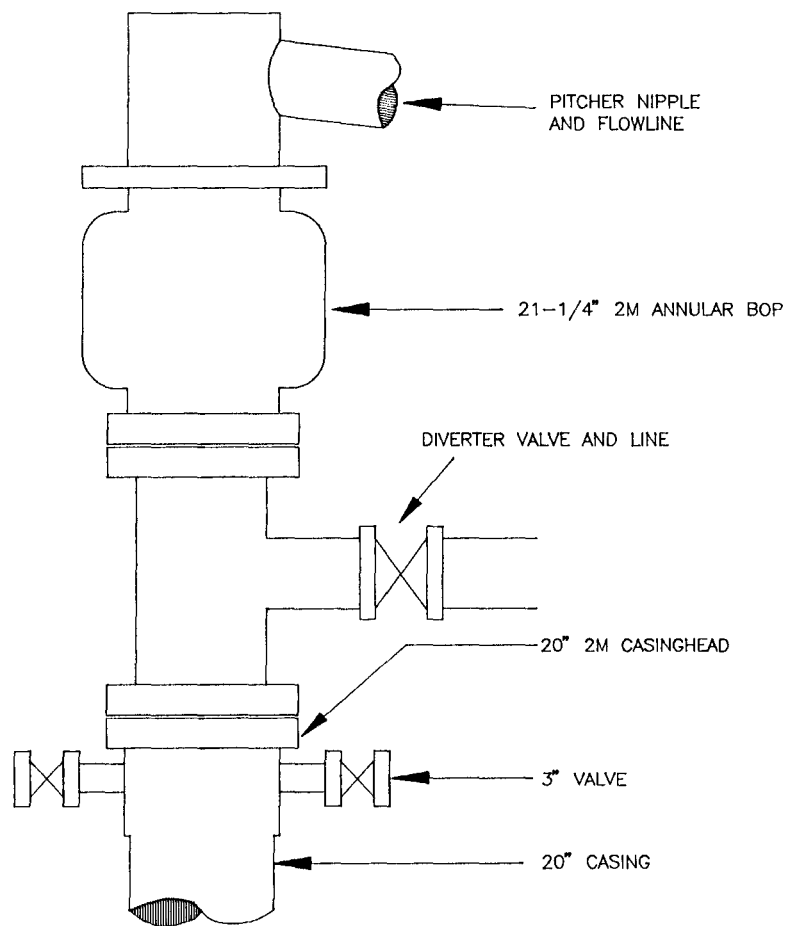
PUNA GEOTHERMAL VENTURE

GEOTHERMAL WELL KS--13
WELL CELLAR

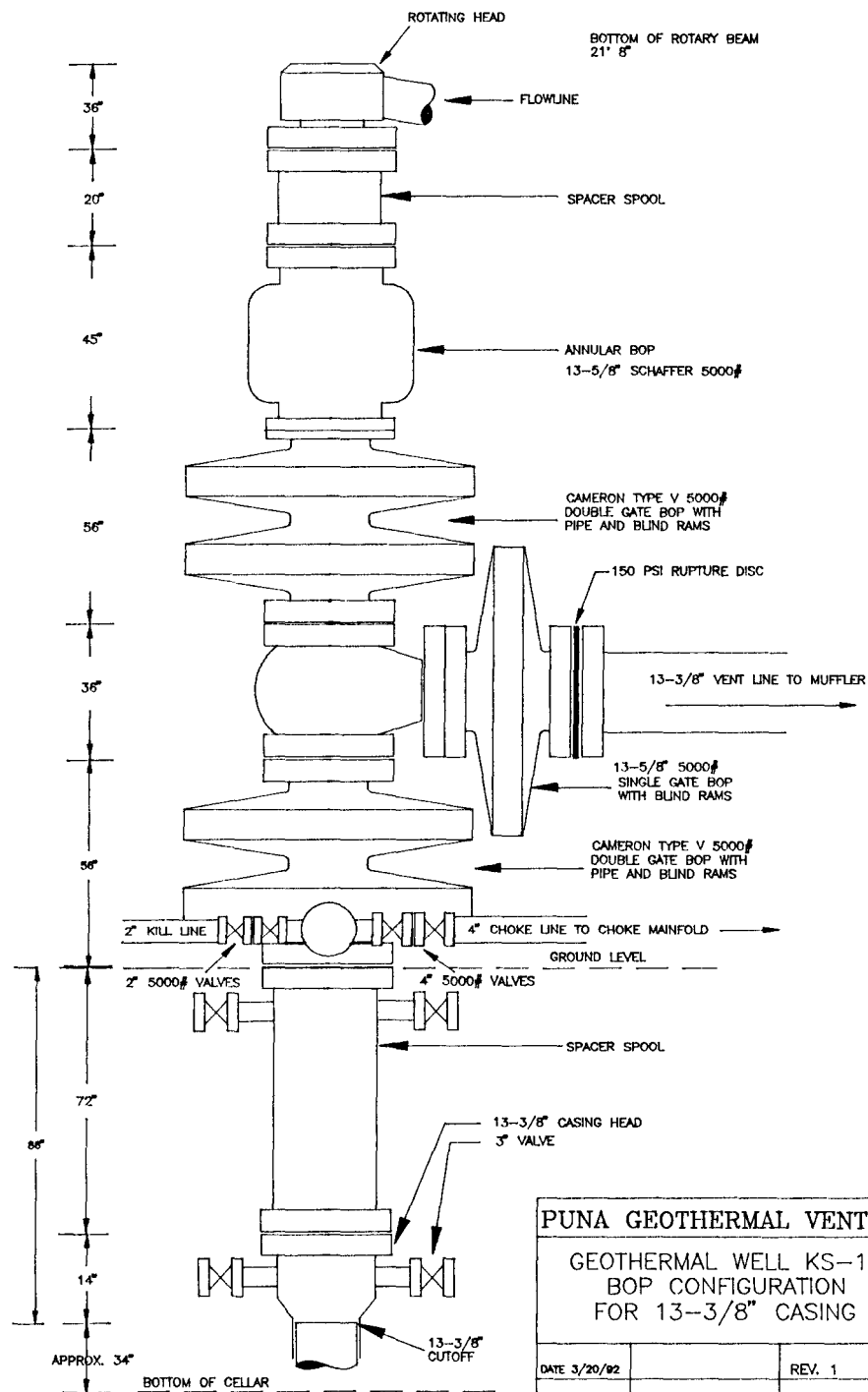
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BY W. TEPLow	FIGURE NO. 3-1







PUNA GEOTHERMAL VENTURE		
GEOTHERMAL WELL KS-13 20" BOP CONFIGURATION		
DATE 3/20/04		REV. 3
BY TEPLON	FILE: P08\K12BOP20.DWG	FIGURE NO. 3--4



PUNA GEOTHERMAL VENTURE

GEOTHERMAL WELL KS-13
BOP CONFIGURATION
FOR 13-3/8" CASING

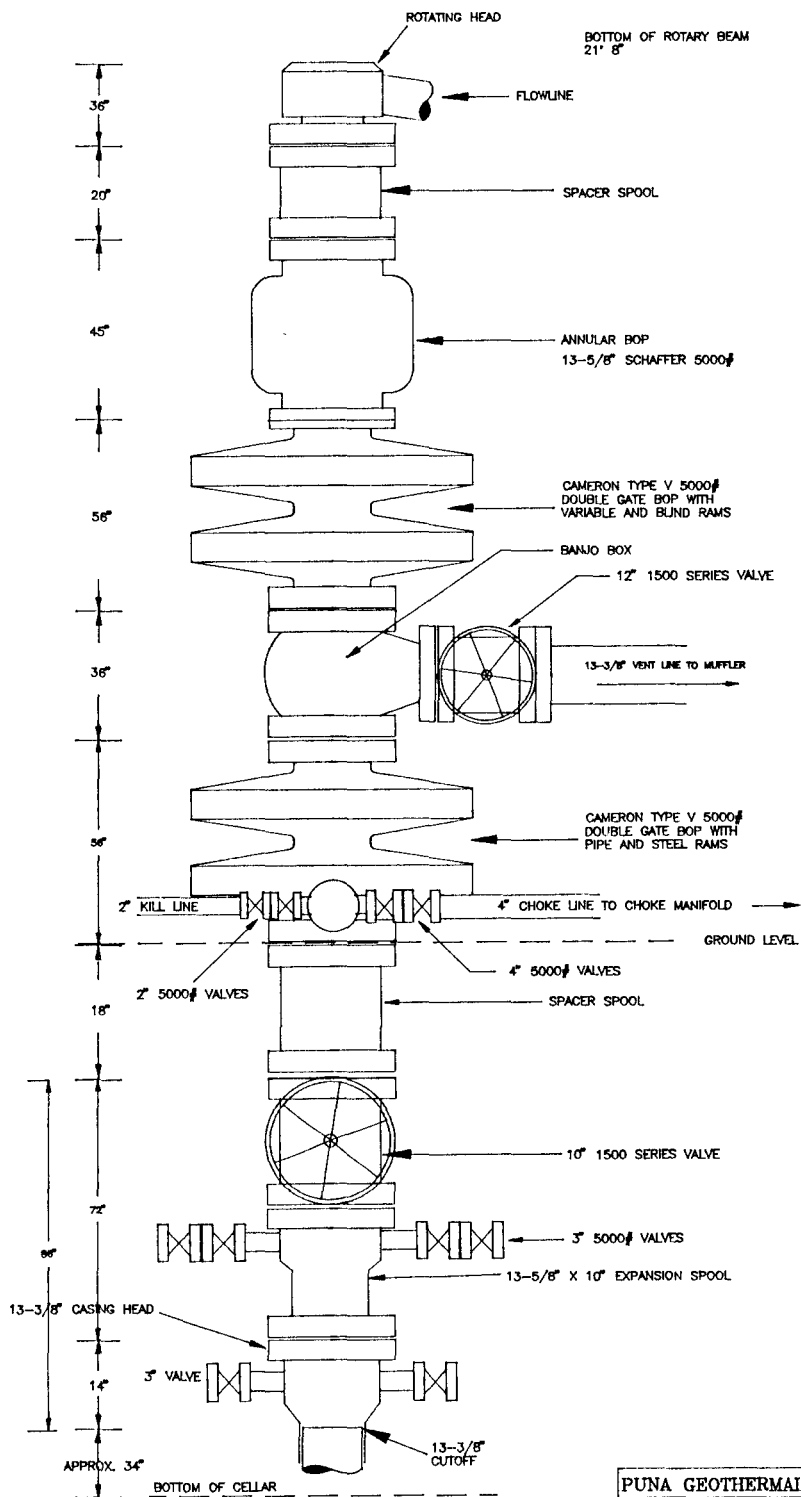
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BY TEPLW

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FIGURE NO. 3-5

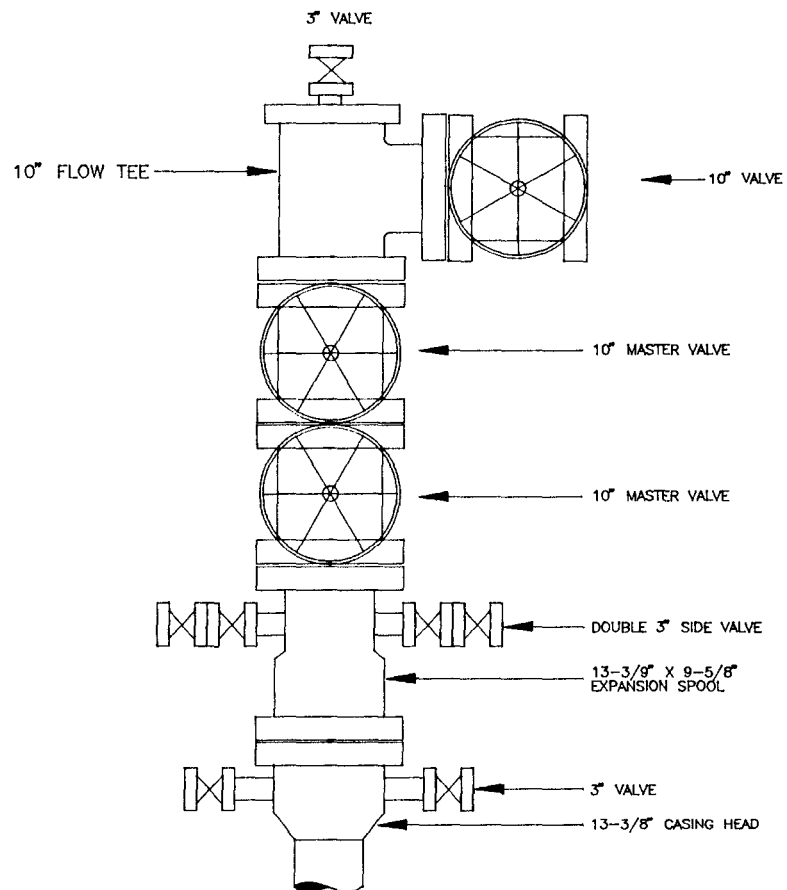


PUNA GEOTHERMAL VENTURE

GEOTHERMAL WELL KS-13
BOP CONFIGURATION
FOR 9-5/8" CASING

DATE 3/30/94	REV. 2
BY TEPLOW	FILE pgs\w12bop8.dwg

FIGURE NO. 3-8



PUNA GEOTHERMAL VENTURE

GEOTHERMAL WELLHEAD
CONFIGURATION
FOR KS-13

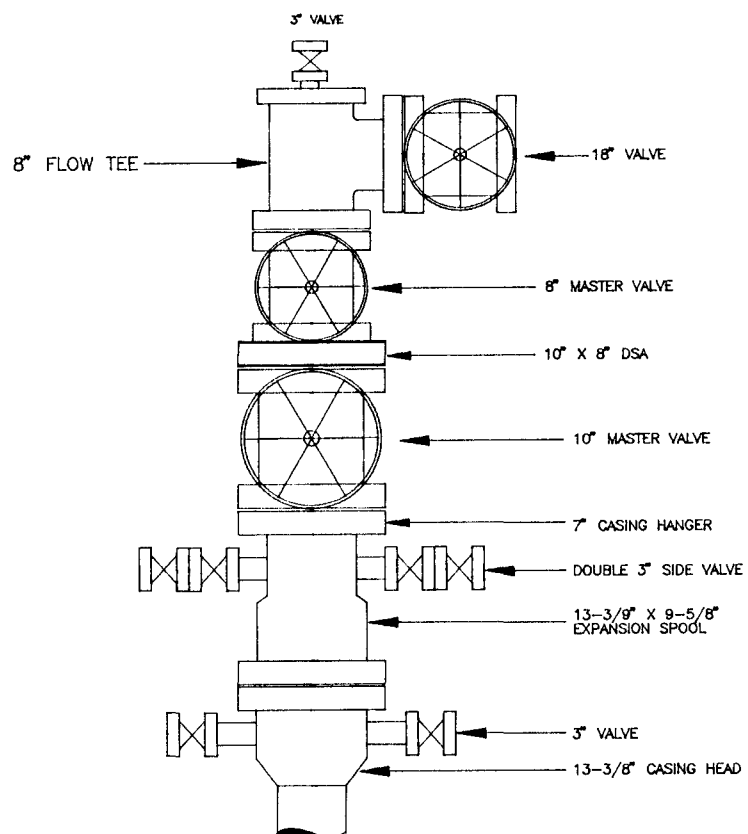
DATE 3/20/04

REV. 1

BY TEPLW

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FIGURE NO. 3-7



PUNA GEOTHERMAL VENTURE

INJECTION WELLHEAD CONFIGURATION FOR KS-13

DATE 3/20/94

REV. 1

BY TEPLW

FILE:PGV\KS12WHDWG

FIGURE NO. 3-7A

